

CLAIMS

1. A basic metal nitrate meeting at least one requirement of the following (a) to (d):

(a) a particle diameter of 0.5 to 40  $\mu\text{m}$ ;

(b) a degree of crystallinity having 0.35 deg or less of a half band width of the peak in the X-ray diffraction;

(c) an initiation temperature of weight loss being 220 °C or higher according to TG/DTA analysis; and

(d) an impurity content of 1,000 ppm or less based on Na atom.

2. The basic metal nitrate as claimed in Claim 1, which is a basic copper nitrate.

3. A gas generating composition comprising the basic metal nitrate as claimed in Claim 1 or 2.

4. A process for producing a basic metal nitrate comprising a step of reacting a metal nitrate with an alkali metal bicarbonate.

Sub-A4 5. The process as claimed in Claim 4, wherein the metal nitrate is at least one metal salt selected from the group consisting of cobalt, copper, zinc, manganese, iron, molybdenum, bismuth and cerium.

6. The process as claimed in Claim 4 or 5, wherein the metal nitrate is copper nitrate.

7. The process as claimed in Claim 6, wherein

copper nitrate is represented by formula (I)



wherein n is 0 to 6.

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8. The process as claimed in any one of Claims 4 to 7, wherein the alkali metal of the alkali metal bicarbonate is at least one selected from sodium, potassium, lithium, rubidium and cesium.

9. The process as claimed in any one of Claims 4 to 8, wherein the alkali metal bicarbonate is sodium bicarbonate or potassium bicarbonate.

10. A gas generating composition comprising a fuel and a basic metal nitrate, the basic metal nitrate meeting at least one requirement selected from the following (a-1) to (a-3):

(a-1) a particle diameter of 0.5 to 40  $\mu\text{m}$ ;

(a-2) a specific surface area of particles being 0.4 to 6.0  $\text{m}^2/\text{g}$ ; and

(a-3) a bulk density of particles being 0.4 g/ml or more.

11. The gas generating composition as claimed in Claim 10, comprising a fuel and a basic metal nitrate, the basic metal nitrate meeting at least one requirement selected from (a-1) to (a-3) and further (b) to (d):

(b) a degree of crystallinity having 0.35 deg or less of a half band width of the peak in the X-ray diffraction;

(c) an initiation temperature of weight loss being 220 °C or higher according to TG-DTA analysis; and

(d) an impurity content of 1,000 ppm or less based on Na atom.

12. A gas generating composition comprising a fuel and a basic metal nitrate, the basic metal nitrate being in the form of secondary particles of coagulated principal particles, the secondary particles meeting at least one requirement selected from the following (a-1) to (a-3):

(a-1) a particle diameter of 0.5 to 40  $\mu\text{m}$ ;

(a-2) a specific surface area of particles being 0.4 to 6.0  $\text{m}^2/\text{g}$ ; and

(a-3) a bulk density of particles being 0.4 g/ml or more.

13. The gas generating composition as claimed in Claim 12, comprising a fuel and a basic metal nitrate, the basic metal nitrate meeting at least one requirement selected from (a-1) to (a-3) and further the following (b) to (d):

(b) a degree of crystallinity having 0.35 deg or less of a half band width of the peak in the X-ray diffraction;

(c) an initiation temperature of weight loss being 220 °C or higher according to TG-DTA analysis; and

(d) an impurity content of 1,000 ppm or less based on Na atom.

14. The gas generating composition as claimed in

Claim 12 or 13, wherein the basic metal nitrate in the form of the secondary particles is formed by coagulating a large number of principal particles having the form of needles to plates and/or spheres to similar shapes thereto.

15. The gas generating composition as claimed in any one of Claims 10 to 14, wherein the fuel is a nitrogen-containing compound.

16. The gas generating composition as claimed in any one of Claims 10 to 15, wherein the fuel is selected from the group consisting of guanidine derivatives, azole derivatives, triazine derivatives and transition metal complexes.

17. The gas generating composition as claimed in any one of Claims 10 to 16, wherein the fuel is nitroguanidine.

18. The gas generating composition as claimed in any one of Claims 10 to 17, wherein the basic metal nitrate is a basic copper nitrate.

19. The gas generating composition as claimed in any one of Claims 10 to 18, which further comprises an additive.

20. The gas generating composition as claimed in Claim 19, wherein the additive is guar gum.

21. The gas generating composition as claimed in any one of claims 10 to 20, which has a weight loss ratio of 2.0 % by weight or less when it is allowed to stand in an

atmosphere of a temperature of 110° for 400 hours.

22. A gas generating composition comprising a fuel and the basic metal nitrate as claimed in Claim 1 or the basic metal nitrate obtained by the process as claimed in Claim

4.

*Sub A6* 23. A gas generating composition comprising (a) at least one guanidine derivative selected from the group consisting of tetrazole derivatives, guanidine, guanidine carbonate, nitroguanidine, dicyandiamide, nitroaminoguanidine and nitroaminoguanidine nitrate and (b) a basic metal nitrate.

24. A gas generating composition comprising (a) at least one guanidine derivative selected from the group consisting of tetrazole derivatives, guanidine, guanidine carbonate, nitroguanidine, dicyandiamide, nitroaminoguanidine and nitroaminoguanidine nitrate, (b) a basic metal nitrate and (c) a binder and/or a slag-forming agent.

*Sub B1* 25. A gas generating composition comprising (a) tetrazole derivatives, guanidine derivatives or a mixture thereof, (b) a basic metal nitrate and (d) a combustion-improving agent.

26. A gas generating composition comprising (a) tetrazole derivatives, guanidine derivatives or a mixture

thereof, (b) a basic metal nitrate, (c) a binder and/or a slag-forming agent and (d) a combustion-improving agent.

27. The gas generating composition as claimed in Claim 25 or 26, wherein (d) the combustion-improving agent is a component to improve combustion properties of the overall gas generating composition, including a burning rate, a duration of combustion and an ignitability.

28. The gas generating composition as claimed in Claim 25, 26 and 27, wherein (d) the combustion-improving agent is at least one selected from the group consisting of silicon nitride, silica, a nitrite, a nitrate, a chlorate or a perchlorate of an alkali metal or an alkaline earth metal ( $\text{KNO}_3$ ,  $\text{NaNO}_3$ ,  $\text{KClO}_4$ ), iron (III) hydroxide oxide [ $\text{FeO}(\text{OH})$ ], copper oxide, iron oxide, zinc oxide, cobalt oxide and manganese oxide.

29. A gas generating composition comprising (a) tetrazole derivatives, guanidine derivatives or a mixture thereof and (b) a basic metal nitrate and meeting at least one requirement selected from the following (1) to (3):

(1) a weight loss ratio of the gas generating composition when the gas generating composition is retained in a closed state at  $90^\circ\text{C}$  for 1,000 hours or at  $110^\circ\text{C}$  for 400 hours is 2.0 % or less,

(2) concentrations of trace gases contained in a gas

generated by the combustion of the gas generating composition, as values measured in a 2,800-liter tank, 400 ppm or less for CO, 40 ppm or less for NO, 8 ppm or less for NO<sub>2</sub> and 100 ppm or less for NH<sub>3</sub>, and

(3) a maximum internal pressure in a gas generator on the combustion of the gas generating composition is 7,840 to 22,500 kPa.

30. A gas generating composition comprising (a) tetrazole derivatives, guanidine derivatives or a mixture thereof, (b) a basic metal nitrate and (c) a binder and/or a slag-forming agent and meeting at least one requirement selected from the following (1) to (3):

(1) a weight loss ratio of the gas generating composition when the gas generating composition is retained in a closed state at 90°C for 1,000 hours or at 110°C for 400 hours is 2.0 % or less,

(2) concentrations of trace gases contained in a gas generated by the combustion of the gas generating composition, as values measured in a 2,800-liter tank, 400 ppm or less for CO, 40 ppm or less for NO, 8 ppm or less for NO<sub>2</sub> and 100 ppm or less for NH<sub>3</sub>, and

(3) a maximum internal pressure in a gas generator on the combustion of the gas generating composition is 7,840 to 22,500 kPa.

31. The gas generating composition as claimed in Claim 29 or 30, which further comprises (d) the combustion-improving agent as claimed in Claim 5 or 6.

32. The gas generating composition as claimed in any one of Claims 23 to 31, wherein the tetrazole derivative as component (a) is at least one selected from the group consisting of tetrazole, 5-aminotetrazole, 5,5'-bi-1H-tetrazole, 5-nitroaminotetrazole, zinc salt of 5-aminotetrazole, copper salt of 5-aminotetrazole, bitetrazole, potassium salt of bitetrazole, sodium salt of bitetrazole, magnesium salt of bitetrazole, calcium salt of bitetrazole, diammonium salt of bitetrazole, copper salt of bitetrazole and melamine salt of bitetrazole.

33. The gas generating composition as claimed in any one of Claims 25 to 31, wherein the guanidine derivative as component (a) is at least one selected from the group consisting of guanidine, mono-, di- or tri-aminoguanidine nitrate, guanidine nitrate, guanidine carbonate, nitroguanidine, dicyandiamide and nitroaminoguanidine nitrate.

34. The gas generating composition as claimed in any one of Claims 23 to 33, wherein the basic metal nitrate as component (b) is at least one selected from the group consisting of a basic copper nitrate, a basic cobalt nitrate,



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a basic zinc nitrate, a basic manganese nitrate, a basic iron nitrate, a basic molybdenum nitrate, a basic bismuth nitrate and a basic cerium nitrate.

35. The gas generating composition as claimed in any one of Claims 23 to 34, wherein component (b) is a mixture of a basic metal nitrate and at least one other oxidizing agent.

36. The gas generating composition as claimed in any one of Claims 23 to 35, wherein component (b) is a mixture of a basic metal nitrate and at least one other oxidizing agent which includes an alkali metal nitrate.

37. The gas generating composition as claimed in any one of Claims 23 to 36, wherein when component (b) is a mixture, the alkali metal nitrate contained as at least one other oxidizing agent is potassium nitrate.

38. The gas generating composition as claimed in any one of Claims 23 to 37, wherein when component (b) is a mixture, the content of the basic metal nitrate in the mixture is 55 to 99.9 % by weight.

39. The gas generating composition as claimed in any one of Claims 24, 26, 27, 28 and 30 to 38, wherein the binder as component (c) is not crosslinkable.

40. The gas generating composition as claimed in any one of Claims 24, 26, 27, 28 and 30 to 38, wherein the binder and/or the slag-forming agent as component (c) is not

crosslinkable and at least one selected from the group consisting of carboxymethylcellulose, sodium carboxymethylcellulose, potassium carboxymethylcellulose, ammonium carboxymethylcellulose, cellulose acetate, cellulose acetatebutylate, methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, ethylhydroxyethyl cellulose, hydroxypropyl cellulose, carboxymethylethyl cellulose, fine crystalline cellulose, polyacrylic amide, aminated compounds of polyacrylic amide, polyacrylic hydrazide, a copolymer of an acrylic amide and a metal salt of acrylic acid, a copolymer of polyacrylic amide and polyacrylic ester, polyvinyl alcohol, acrylic rubber, guar gum, starch, polysaccharides including starch, silicone, molybdenum disulfide, Japanese acid clay, talc, bentonite, diatomaceous earth, kaolin, calcium stearate, silica, alumina, sodium silicate, silicon nitrate, silicon carbide, hydrotalcite, mica, a metal oxide, a metal hydroxide, a metal carbonate, a basic metal carbonate and a molybdate.

41. The gas generating composition as claimed in Claim 40, wherein the metal oxide as component (c) is at least one selected from the group consisting of copper oxide, iron oxide, zinc oxide, cobalt oxide, manganese oxide, molybdenum oxide, nickel oxide and bismuth oxide, the metal hydroxide is at least one selected from the group consisting of cobalt hydroxide and aluminum hydroxide, the metal carbonate or the

basic metal carbonate is at least one selected from the group consisting of calcium carbonate, cobalt carbonate, a basic zinc carbonate and a basic copper carbonate, and the molybdate is at least one selected from the group consisting of cobalt molybdate and ammonium molybdate.

42. The gas generating composition as claimed in Claim 23, which comprises (a) diammonium salt of bitetrazole and (b) a basic copper nitrate.

43. The gas generating composition as claimed in Claim 42, which comprises 15 to 45 % by weight of (a) diammonium salt of bitetrazole and 55 to 85 % by weight of (b) a basic copper nitrate.

44. The gas generating composition as claimed in Claim 24, which comprises (a) diammonium salt of bitetrazole, (b) a basic copper nitrate and (c) sodium carboxymethylcellulose.

45. The gas generating composition as claimed in Claim 44, which comprises 15 to 40 % by weight of (a) diammonium salt of bitetrazole, 45 to 80 % by weight of (b) a basic copper nitrate and 0.1 to 15 % by weight of (c) sodium carboxymethylcellulose.

46. The gas generating composition as claimed in Claim 24, which comprises (a) diammonium salt of bitetrazole, (b) a basic copper nitrate, (c-1) sodium

carboxymethylcellulose and (c-2) component (c) as claimed in Claim 39, 40 or 41 except said (c-1).

47. The gas generating composition as claimed in Claim 46, which comprises 15 to 35 % by weight of (a) diammonium salt of bitetrazole, 30 to 70 % by weight of (b) a basic copper nitrate, 0.1 to 15 % by weight of (c-1) sodium carboxymethylcellulose and 1 to 45 % by weight of (c-2).

48. The gas generating composition as claimed in Claim 23, which comprises (a) nitroguanidine and (b) a basic copper nitrate.

49. The gas generating composition as claimed in Claim 48, which comprises 30 to 70 % by weight of (a) nitroguanidine and 30 to 70 % by weight of (b) a basic copper nitrate.

50. The gas generating composition as claimed in Claim 24, which comprises (a) nitroguanidine, (b) a basic copper nitrate and (c) sodium carboxymethylcellulose.

51. The gas generating composition as claimed in Claim 50, which comprises 15 to 55 % by weight of (a) nitroguanidine, 45 to 70 % by weight of (b) a basic copper nitrate and 0.1 to 15 % by weight of (C) sodium carboxymethylcellulose.

52. The gas generating composition as claimed in claim 24, which comprises (a) nitroguanidine, (b) a basic

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copper nitrate, (c-1) sodium carboxymethylcellulose and (c-2) component (c) as claimed in Claim 39, 40 or 41 except said (c-1).

53. The gas generating composition as claimed in Claim 52, which comprises 15 to 50 % by weight of (a) nitroguanidine, 30 to 65 % by weight of (b) a basic copper nitrate, 0.1 to 15 % by weight of (c-1) sodium carboxymethylcellulose and 1 to 40 % by weight of (c-2).

54. The gas generating composition as claimed in Claim 24, which comprises (a) nitroguanidine, (b) a basic copper nitrate and (c) guar gum.

55. The gas generating composition as claimed in Claim 54, which comprises 20 to 60 % by weight of (a) nitroguanidine, 35 to 75 % by weight of (b) a basic copper nitrate and 0.1 to 10 % by weight of guar gum.

56. The gas generating composition as claimed in Claim 24, which comprises (a) nitroguanidine, (b) a basic copper nitrate, (c-1) guar gum and (c-2) component (c) as claimed in Claim 39, 40 or 41 except said (c-1).

57. The gas generating composition as claimed in Claim 56, which comprises 20 to 60 % by weight of (a) nitroguanidine, 30 to 70 % by weight of (b) a basic copper nitrate, 0.1 to 10 % by weight of (c-1) guar gum and 0.1 to 10 % by weight of (c-2).

58. The gas generating composition as claimed in

Claim 27, which comprises (a) nitroguanidine, (b) a basic copper nitrate, (c) guar gum and (d) a combustion-improving agent.

59. The gas generating composition as claimed in Claim 58, which comprises 20 to 60 % by weight of (a) nitroguanidine, 35 to 75 % by weight of (b) a basic copper nitrate, 0.1 to 10 % by weight of (c) guar gum and 0.1 to 15 % by weight of (d) a combustion-improving agent.

60. The gas generating composition as claimed in Claim 58 or 59, wherein (d) the combustion-improving agent is silica.

61. The gas generating composition as claimed in Claim 23, which comprises (a) dicyandiamide and (b) a basic copper nitrate.

62. The gas generating composition as claimed in Claim 61, which comprises 15 to 30 % by weight of (a) dicyandiamide and 70 to 85 % by weight of (b) a basic copper nitrate.

63. The gas generating composition as claimed in Claim 24, which comprises (a) dicyandiamide, (b) a basic copper nitrate and (c) sodium carboxymethylcellulose.

64. The gas generating composition as claimed in Claim 63, which comprises 15 to 25 % by weight of (a) dicyandiamide, 60 to 80 % by weight of (b) a basic copper nitrate

and 0.1 to 20 % by weight of (c) sodium carboxymethylcellulose.

65. The gas generating composition as claimed in Claim 24, which comprises (a) dicyandiamide, (b) a basic copper nitrate, (c-1) sodium carboxymethylcellulose and (c-2) component (c) as claimed in Claim 39, 40 or 41 except said (c-1).

66. The gas generating composition as claimed in Claim 65, which comprises 15 to 25 % by weight of (a) dicyandiamide, 55 to 75 % by weight of (b) a basic copper nitrate, 0 to 10 % by weight of (c-1) sodium carboxymethylcellulose and 1 to 20 % by weight of (c-2) component (c).

67. A gas generating composition comprising (a) guanidine nitrate, (b) a basic copper nitrate and (c) sodium carboxymethylcellulose.

68. The gas generating composition as claimed in Claim 67, which comprises 15 to 60 % by weight of (a) guanidine nitrate, 40 to 70 % by weight of (b) a basic copper nitrate and 0.1 to 15 % by weight of (c) sodium carboxymethylcellulose.

69. A gas generating composition comprising (a) guanidine nitrate, (b) a basic copper nitrate, (c-1) sodium carboxymethylcellulose and (c-2) component (c) as claimed in Claim 39, 40 or 41 except said (c-1).

70. The gas generating composition as claimed in Claim 69, which comprises 15 to 55 % by weight of (a) guanidine nitrate, 25 to 60 % by weight of (b) a basic copper nitrate, 0.1 to 15 %

by weight of (c-1) sodium carboxymethylcellulose and 1 to 40%  
by weight of (c-2) component (c).

71. The gas generating composition as claimed in  
any one of Claims 35 to 70, which comprises a mixture of a basic  
copper nitrate and potassium nitrate as component (b).

72. An inflator for an air bag using the gas  
generating composition as claimed in any one of Claims 3 and  
10 to 71.

73. A molded article in the form of a single-  
perforated cylinder, a perforated (porous) cylinder or pellets,  
the molded article being obtained from the gas generating  
composition as claimed in any one of Claims 3 and 10 to 71.

74. An inflator for an air bag using the molded  
article as claimed in Claim 73.